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Research on Analysis Model of Discipline Cluster System Learning Competence based on Self-organization Theory

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Abstract: This study will discuss the concept of discipline cluster and discipline cluster system has been put forward and then analyses their basic connotation and function of discipline cluster system. This study discusses the dissipation structure character of discipline cluster system, puts forward the disturbing factors of discipline cluster system evolution, analyses the self-organization connection of discipline cluster system, favorable discipline cluster construction will benefit from these in a certain extent. And then, this study researches the opening extent of academic team how to affect the academic team creativity and subject cluster core competence.

Key words: Discipline cluster system, self-organization, academic team, core competence, opening extent

INTRODUCTION

Discipline cluster: The concept of "Cluster" roots in ecology, the original intention of cluster is the biology colony that perch in the same habitat with symbiotic relation (Porter, 1998). And now is widely used in industry economy, that is industry cluster, which means the interconnected companies and associated institutions in geographically close, they are the same or related industries in a specific field, which connect together by the common nature and complementarities.

Applying the concept of cluster into the field education, that is discipline cluster, it is the aggregation of different and closed discipline as well as their relations that taking one certain or consanguineous relation discipline or based on one basic theory as the core, relying on related disciplines and supported by basic disciplines (such as mathematics and English etc basic disciplines). It can be divided into nuclear and non-nuclear discipline cluster (Or called Collaborative Discipline cluster). The nuclear discipline cluster is take one certain discipline as the core or based on the together basic theory; the non-nuclear discipline cluster (Or called Collaborative Discipline cluster) is to take the related discipline as the core. Discipline Cluster is a opening and complex system and a dissipative framework. It requires constantly exchange with the outside world for material, personnel, information and absorb the negative entropy flow-enough material, Energy and information and then by the processing in the system, then export new information and release energy to the external environment. Meanwhile, the discipline is a cluster of non-equilibrium system of very complexity; there does exist complicatedly

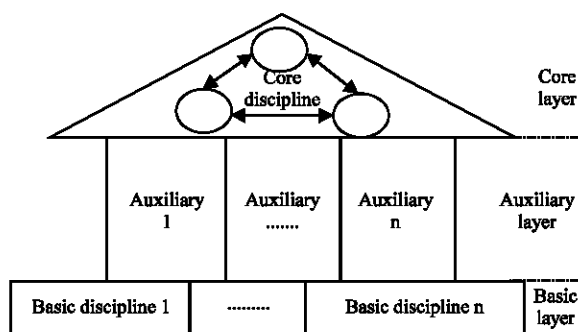


Fig. 1: Figure of discipline cluster basic construction

nonlinear interaction and feedback loop among composed factors. The basic configuration of discipline is as Fig. 1 showing.

The core layer indicates the certain discipline, or multi-discipline that has high relation or based on the same theory. The auxiliary layer indicates the related auxiliary discipline that derived from the core discipline or the same theory. The basic layer indicates the basic disciplines, such as such as mathematics, foreign languages.

From the point of system, university is composed by discipline cluster sub-system and other assistant subsystems. Because of the economy, the subsystem that consists of basic discipline lies in university and so we believe that the main research disciplines inspection group is the relationship between core disciplines and supplementary disciplines.

Discipline cluster system: Discipline cluster system consists of discipline cluster, academic team, the material

and technical foundation, cultural atmosphere and the system (or mechanism). From the previous analysis, we know that discipline is the base that university performs its functions and the base that specialty and scientific establish. The deploying profit of people, finance and material in university is realized by discipline and the character, advantage and science report is embodied by discipline. And so, discipline system is most important part in university, the material and technical foundation which is the inputting factors, in a certain cultural atmosphere, relying on some systems (mechanism), acts on discipline by academic team, thereby completes university functions. From that perspective, the basic function of discipline cluster system is to cultivate people, academic research, social services and the conversion of academic results.

METHODS

Self-organization mechnism of discipline cluster system:

The self-organization of discipline system is to spontaneously form the structure full of organizational character from chaos phase under the condition of guarantying the exchange material, energy and information with the outside (Nicolis and Prigogine, 1973; Kan and Shen, 1982; Ebeling and Ulbricht, 1996). Leading by the order parameter, nonlinear interaction and restraint of the internal and external factors and other subsystems will form the dissipative structure, just as Fig. 2 showing.

DCS indicates discipline cluster system, DC indicates discipline cluster, AT indicates academic team, AC indicates cultural atmosphere, PS indicates development status of university, SB indicates material and technical foundation, ME indicates university environment.

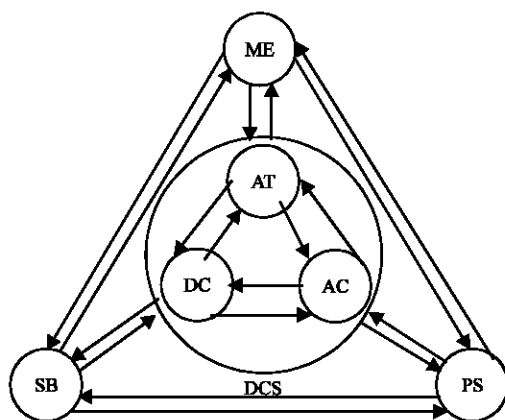


Fig. 2: Figure of self-organization of discipline cluster system

In Fig. 2, the change of the various factors of DC, AT, AC, PS, SB and ME changes is decided by their self-development condition and the nature of various factors. Discipline cluster system is enslaved to the influence and restraint of subsystem and also a have feedback, change the relationship between the subsystems, the whole system nature depends on the impact of the interaction between subsystems.

Due to the unstable variable exceed the threshold value, structure of discipline self-organization system will mutate. Research level of academic team in discipline cluster system is an un-damping and unstable variable, research level of academic team always developed to the more senior level. The original level of scientific research is an impetus and condition for further development. The development and change of scientific research level decides the status of discipline cluster system. When it exceeds a certain threshold, discipline cluster system will change, which will be replaced by the new structure.

When the old structure has not completely disappeared, the new structure is far from being established, discipline cluster system is the chaotic system. At this time, the self-organization process in discipline cluster system is very complex. The structure of discipline cluster system is to realize self-organization by diffusing and competing. At this juncture, the change scope of variables in the system is within the threshold, the effect that the variable to system structure is to be control.

When the linkage between the subsystems in discipline cluster system can restrict the phase of subsystem and the system is to show as the certain structure, this is called order (Yang, 2012). It is the fruit that interacted and diffused by every elements and subsystems.

The process of realizing orderly development of system by self-organization can show that the evolution of discipline cluster system structure is a self-organization process. It is not according to the optimal model that had been predetermined, but is gradually evolving and forms the macro-structure at last. Therefore, in the development of discipline cluster system, it is not necessary to assume and optimally design the macro-structure; it is necessary to optimally design the realizing process of every stage. Every stage of development to achieve the optimum design is the real significance of optimization.

Analysis model of learning competence: Discipline cluster is the opening and complex system and a dissipative structure. At first, discipline is an opening system, because it requires constantly exchange with the outside world for material, personnel, information

exchange (Prahalad and Hamel, 1990). Meanwhile, it is a very complex non-equilibrium system, there does exist complicatedly nonlinear interaction and feedback loop among composed factors. Therefore, in the discipline cluster system the forming condition of dissipative structure completely possessed. As a dissipative structure system, discipline cluster need to keep opening to the outside world and obtain the necessary material for sustainable development. Because of the complex non-linear relation among the discipline cluster system, change of any factor will arouse the change of other factors, after the inevitable changes in the factors and give feedback to the initial changes in the factors affecting the new. The self-organization process of the sustainable development of discipline cluster system is be controlled by the feedback mechanism which effected by the non-linear relation. Different cultural atmosphere is bound to affect the opening extent of the academic team; the opening extent of academic team is the key factor of affecting the core competence of discipline cluster.

Maynard Smith thought, the competing result between the species mainly depended on resources and the environment in theoretical Biology, there is no evident relation between the environmental Change and adaptability of animal or human behavior (Smith, 1974). Weber and Whorf thought that culture has played an important role in capitalism development and origin of modern science (Weber, 1930; Whorf, 1956), Kikuchi also saw individual differences in the relatively large difference between the East and West and put forward a one-dimensional model of measuring the degree of individualism (Kikuchi, 1981). Chen discussed that different cultures how to affect one species behavior and discussed different cultures how to affect two species behavior (Chen, 2000). This study will use the above method to analyze information diffusion model of one academic team and then discuss studying and competing model of two academic teams.

An information diffusion model of no central information source can be expressed as following (Barthodmew, 1978; Horsthemke and Lefever, 1984):

$$\frac{\partial n}{\partial t} = kn(N-n) - dn(1 - \alpha \frac{n}{N}) \quad (1)$$

where, N indicates the people scale of academic team, n indicates the numbers of academic team that have owned information, $(N-n)$ indicates the numbers of academic team that need accept new information, k indicates the growth rate of accepting new information in the studying process:

$$dn(1 - \alpha \frac{n}{N})$$

indicates the eliminating rate, d indicates the measuring criterion of study capability or the difficult extent of mastering technology, α indicates the opening extent of academic team and $\alpha \in [0, 1]$, or means the accepting extent of strange thing. If α is very small, that means the few of accepting new information, the bigger of the eliminating rate; if α is very big, that means the more if accepting new information, the smaller of the eliminating rate.

Due to the ever-changing external environment, Eq. 1 can change the following randomized equation:

$$\frac{\partial x}{\partial t} = kx(N-x) - dx(1 - \alpha \frac{x}{N}) + \sigma k \xi(t) \quad (2)$$

where, x indicates random variable, $\xi(t)$ indicates random disturbance item, σ indicates the variance of random disturbance item.

According to Eq. 2, the extremism of steady-state probability density of Fokker-Planck equation can be solved as following:

$$x_m = \begin{cases} N(1 - \frac{d}{kN} - \frac{K\alpha^2}{2N}) / (1 - \frac{d\alpha}{kN}) & \sigma < \sigma_c \\ 0 & \sigma > \sigma_c \end{cases} \quad (3)$$

And where:

$$\sigma^2 = \frac{2}{k}(N - \frac{d}{k})$$

And now, compare the two academic team of different opening extent, supposing $\alpha_1 < \alpha_2$. Based on the certain material and technical circumstances, in the Steady-state solution, the number (n_1) of have mastered information in the academic team of small opening extent is smaller than the number (n_2) in the academic team of big opening extent and that shows that when a new message arrives, the potential of absorbing new information in the academic team of big opening extent is bigger than in the academic team of small opening extent. This means that the academic team of big opening extent has strongly creating capability. And we can draw that the core competence of discipline cluster with big opening extent academic team is superior to small opening extent academic team.

And now, we discuss the studying and competing model of two academic teams with different opening extent (Supposing $\alpha_1 < \alpha_2$), the model is following:

$$\begin{cases} \frac{\partial n_1}{\partial t} = k_1 n_1 (N_1 - n_1 - n_2) - d_1 n_1 (1 - \alpha_1 \frac{n_1}{N}) \\ \frac{\partial n_2}{\partial t} = k_2 n_2 (N_2 - n_2 - n_1) - d_2 n_2 (1 - \alpha_2 \frac{n_2}{N}) \end{cases} \quad (4)$$

where, n_1 , n_2 , respectively indicate the number that has mastered information in two academic teams with different opening extent. Supposing, $k_1 = k_2 = k$, $N_1 = N_2 = N$. So, formula 1 can change to formula 5, as following:

$$\begin{cases} \frac{\partial n_1}{\partial t} = s_1 n_1 (M_1 - n_1 - \beta_{12} n_2) \\ \frac{\partial n_2}{\partial t} = s_2 n_2 (M_2 - n_2 - \beta_{21} n_1) \end{cases} \quad (5)$$

where, M_i , s_i , β_{ij} , respectively indicate the effective load, the effectively growth rate and the effectively competing coefficient based on certain material and technology, i and j , respectively indicate the academic team with different opening extent:

$$M_i = (N - \frac{d_i}{k}) / (1 - \frac{\alpha_i d_i}{kN}) \quad (6)$$

$$s_i = k(1 - \frac{\alpha_i d_i}{kN}) \quad (7)$$

$$\beta_{ji} = k(1 - \frac{\alpha_j d_j}{kN}) \quad (8)$$

From Eq. 8, the concomitant condition of two academic teams with different opening extent is as following:

$$\beta_{ji} < M_j < M/\beta_{ij} \quad (9)$$

That is:

$$(1 - \frac{\alpha_i d_i}{kN})(1 - \frac{\alpha_j d_j}{kN}) > 1 \quad (10)$$

RESULTS

It is can be seen from the above formula, the two academic teams with small opening extent can coexist. The ultimately competing result is that one team completely replaced by another team.

If two teams have the same studying capability ($d_1 = d_2$), the two academic teams with big opening extent can coexist, ability to learn, the greater openness of the

two can co-exist with the academic team. At this point the core competence of discipline cluster is bigger than the above case. If the difference of opening extent between the two academic teams is bigger, the finally competing result is that the academic team with big opening extent will replace the academic team with small opening extent. At this point the core competence of discipline cluster is smaller than the case that the two academic teams with big opening extent coexist. If the academic team with lower opening extent wants to acquire advantage in competition, the one is to enhance the studying capability; another is to increase the opening extent of the academic team.

If the two academic teams have different studying capability ($d_1 \neq d_2$) and opening extent ($\alpha_1 \neq \alpha_2$), the competing result will be diversification.

CONCLUSIONS

The study presents the basic structure of discipline cluster, which are core layer, auxiliary layer and basic layer. The contents and function of discipline cluster system is discussed and the dissipative structure nature is discussed, too. And the disturbing factors of affecting the development of discipline cluster system include development status of university, academic team, development strategy of discipline cluster, material and technological foundation, cultural atmosphere and environment of schools (micro-environment). At last, the self-organization relationship of discipline cluster system is analyzed. And then discussed how the academic team with different opening extent affects the core competence of discipline cluster. And think that different cultural atmosphere affect academic team, so the opening extent of academic team is different and the academic team with big opening extent will acquire advantage in competition and the core competence of discipline cluster that this team have researched will be strong.

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